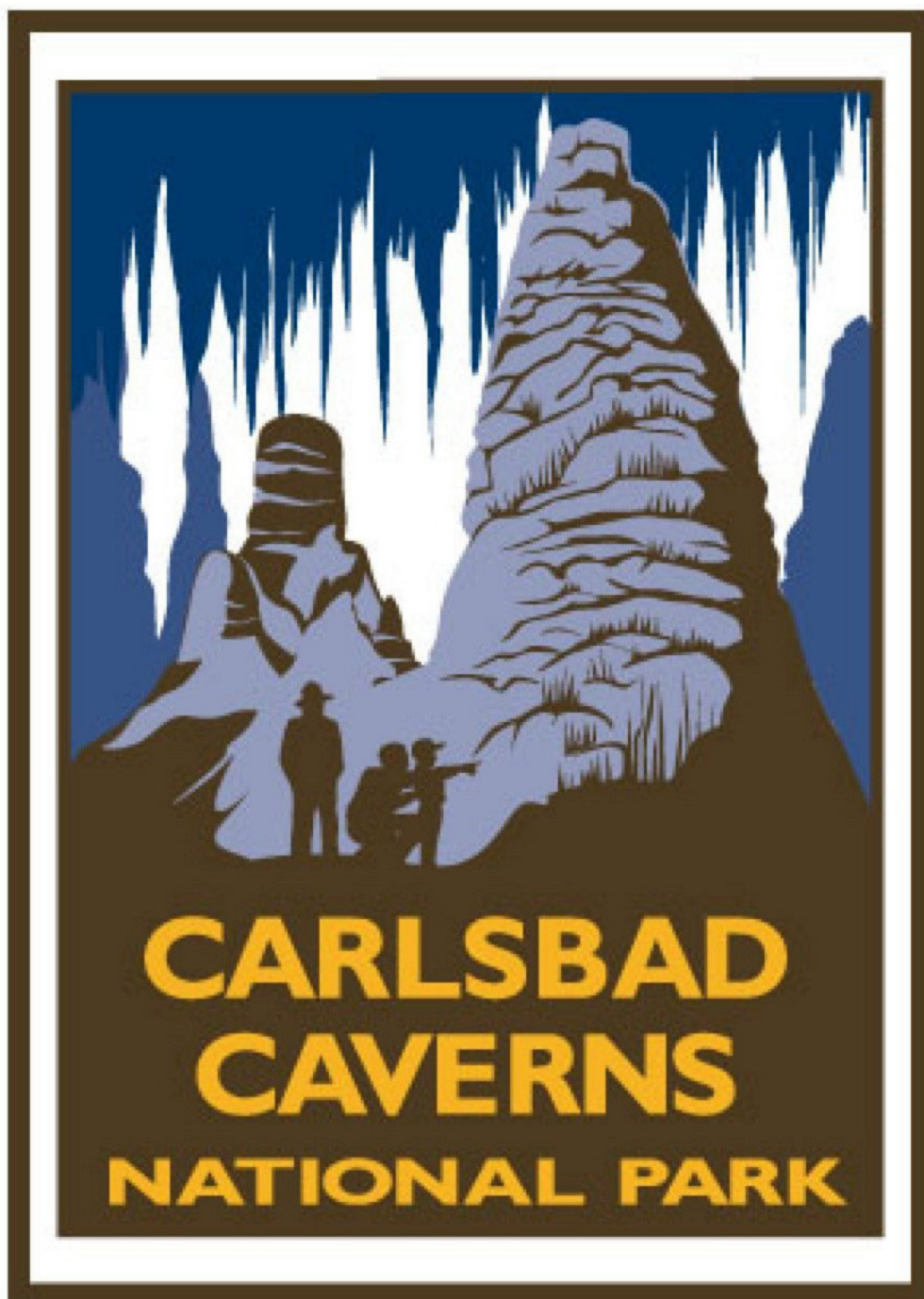




High School Geology



Carlsbad Caverns National Park

High School Geology Curriculum

New Mexico Science Content Standards and Benchmarks	42
Texas Essential Knowledge and Skills for Science	43
Glossary of Terms.....	50
Curriculum Supplies List.....	70

New Mexico Content Standards and Benchmarks

Science

Content Standards	Benchmarks
1. Students will understand science concepts of order and organization.	b
2. Students will use evidence, models, and explanations to explore the physical world.	b
3. Students will use form and function to organize and understand the physical world.	none
4. Students will understand the physical world through the concepts of change, equilibrium, and measurement.	a, b, c, e, f
5. Students will acquire the ability to do scientific inquiry.	a, b,
6. Students will understand the process of scientific inquiry.	a, c, d, g, h
7. Students will know and understand the properties of matter.	a, b, c
8. Students will know and understand the properties of fields, forces, and motion.	none
9. Students will know and understand the concepts of energy and the transformation of energy.	a, b
10. Students will know and understand the characteristics that are the basis for classifying organisms.	a
11. Students will know and understand the synergy among organisms and the environments of organisms.	b, c, e, f,
12. Students will know and understand properties of Earth Science.	a, b, c, d, e, f, g, h
13. Students will know and understand basic concepts of cosmology.	none
14. Students will know and understand the differences between science and technology.	d
15. Students will know and understand the impact between science and technology in society.	e, g
16. The students will know and understand the relationship between natural hazards and environmental risks for organisms.	c

Texas Essential Knowledge and Skills for Science

112.42 Integrated Physics and Chemistry

Scientific Processes and Concepts	Student Expectations
1. The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.	
2. The student uses scientific methods during field and laboratory investigations.	
3. The student uses critical thinking and scientific problem solving to make informed decisions.	
4. The student knows concepts of force and motion evident in everyday life.	
5. The student knows the effects of waves on everyday life.	
6. The student knows the impact of energy transformations in everyday life.	
7. The student knows relationships exist between properties of matter and its components.	
8. The student knows that changes in matter affect everyday life.	
9. The student knows how solution chemistry is a part of everyday life.	

Texas Essential Knowledge and Skills for Science

112.43 Biology

Scientific Processes and Concepts	Student Expectations
1. Scientific processes. The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.	
2. Scientific processes. The student uses scientific methods during field and laboratory investigations.	
3. Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions.	
4. Science concepts. The student knows that cells are basic structures of all living things and have specialized parts that perform specific functions, and that viruses are different from cells and have different properties and functions.	
5. Science concepts. The student knows how an organism grows and how specialized cells, tissues, and organs develop.	
6. Science concepts. The student knows the structures and functions of nucleic acids in the mechanisms of genetics.	
7. Science concepts. The student knows the theory of biological evolution.	
8. Science concepts. The student knows applications of taxonomy and can identify its limitations.	
9. Science concepts. The student knows metabolic processes and energy transfers that occur in living organisms.	
10. Science concepts. The student knows that, at all levels of nature, living systems are found within other living systems, each with its own boundary and limits.	
11. Science concepts. The student knows that organisms maintain homeostasis.	
12. Science concepts. The student knows that interdependence and interactions occur within an ecosystem.	
13. Science concepts. The student knows the significance of plants in the environment.	

Texas Essential Knowledge and Skills for Science

112.44 Environmental Systems

Scientific Processes and Concepts	Student Expectations
1. Scientific processes. The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.	
2. Scientific processes. The student uses scientific methods during field and laboratory investigations.	
3. Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions.	
4. Science concepts. The student knows the relationships of biotic and abiotic factors within habitats, ecosystems, and biomes.	
5. Science concepts. The student knows the interrelationships among the resources within the local environmental system.	
6. Science concepts. The student knows the sources and flow of energy through an environmental system.	
7. Science concepts. The student knows the relationship between carrying capacity and changes in populations and ecosystems.	
8. Science concepts. The student knows that environments change.	

Texas Essential Knowledge and Skills for Science

112.45 Chemistry

Scientific Processes and Concepts	Student Expectations
1. The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.	
2. The student uses scientific methods during field and laboratory investigations.	
3. Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions.	
4. The student knows the characteristics of matter.	
5. The student knows that energy transformations occur during physical or chemical changes in matter.	
6. The student knows that atomic structure is determined by nuclear composition, allowable electron cloud, and subatomic particles.	
7. The student knows the variables that influence the behavior of gases.	
8. The student knows how atoms form bonds to acquire a stable arrangement of electrons.	
9. The student knows the processes, effects, and significance of nuclear fission and nuclear fusion.	
10. The student knows common oxidation-reduction reactions.	
11. The student knows that balanced chemical equations are used to interpret and describe the interactions of matter.	
12. The student knows the factors that influence the solubility of solutes in a solvent.	
13. The student knows the relationships among the concentration, electrical conductivity, and colligative properties of a solution.	
14. The student knows the properties and behavior of acids and bases.	
15. The student knows factors involved in chemical reactions.	

Texas Essential Knowledge and Skills for Science

112.46 Aquatic Science

Scientific Processes and Concepts	Student Expectations
1. Scientific processes. The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.	
2. Scientific processes. The student uses scientific methods during field and laboratory investigations.	
3. Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions.	
4. Science concepts. The student knows the components of aquatic ecosystems.	
5. Science concepts. The student knows the relationships within and among the aquatic habitats and ecosystems in an aquatic environment.	
6. Science concepts. The student knows the roles of cycles in an aquatic environment.	
7. Science concepts. The student knows environmental adaptations of aquatic organisms.	
8. Science concepts. The student knows that aquatic environments change.	
9. Science concepts. The student knows that geological phenomena and fluid dynamics affect aquatic systems.	
10. Science concepts. The student knows the origin and use of water in a watershed.	

Texas Essential Knowledge and Skills for Science

112.49 Geology, Meteorology, and Oceanography

Scientific Processes and Concepts	Student Expectations
1. Scientific processes. The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.	
2. Scientific processes. The student uses scientific methods during field and laboratory investigations.	
3. Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions.	
4. Science concepts. The student knows the Earth's unique characteristics and conditions.	
5. Science concepts. The student knows about the formation and history of the Earth.	
6. Science concepts. The student knows the processes of plate tectonics.	
7. Science concepts. The student knows the origin and composition of minerals and rocks and the significance of the rock cycle.	
8. Science concepts. The student knows the processes and end products of weathering.	
9. Science concepts. The student knows the role of natural energy resources.	
10. Science concepts. The student knows the interactions that occur in a watershed.	
11. Science concepts. The student knows characteristics of oceans.	
12. Science concepts. The student knows characteristics of the atmosphere.	
13. Science concepts. The student knows the role of energy in governing weather and climate.	

Texas Essential Knowledge and Skills for Science

112.47 Physics

Scientific Processes and Concepts	Student Expectations
1. Scientific processes. The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices.	
2. Scientific processes. The student uses scientific methods during field and laboratory investigations.	
3. Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions.	
4. Science concepts. The student knows the laws governing motion.	
5. Science concepts. The student knows that changes occur within a physical system and recognizes that energy and momentum are conserved.	
6. Science concepts. The student knows forces in nature.	
7. Science concepts. The student knows the laws of thermodynamics.	
8. Science concepts. The student knows the characteristics and behavior of waves.	
9. Science concepts. The student knows simple examples of quantum physics.	

Glossary of Terms

A

Absolute dating: dating techniques performed to produce a numerical age in years.

Aerial photograph: photograph of the Earth from the air, either by plane or space shuttle.

Alfred Wegner: the German meteorologist who used: 1) the fit of the continents, 2) locations of past glaciations, 3) distribution of equatorial regions, 4) distribution of fossils, and 5) matching geologic units to suggest the previous existence of Pangea and the Theory of Continental drift in the 1930s.

Algae: a collection of plant species that thrive in wet conditions; many are unicellular organisms (common types found in the Capitan Formation during the Permian were: *Tubiphytes* and *Archaeolithoporella*).

Algal mat: a layered communal growth of algae observed in fossils and in present day tidal zones associated with carbonate sediments.

Alluvium: unconsolidated terrestrial sediment composed of sorted or unsorted sand, gravel, and clay that had been deposited by water.

Ammonite: an extinct marine Cephalopod mollusk that had an elaborately coiled and chambered shell which display intricately shaped septa and sutures.

Analog: a modern environmental setting and associated geological processes that are analogous or similar to a paleoenvironment and the processes that formed it.

Anticline: a fold with an arch-like shape (convex-up).

Aquifer: sediment or rocks, such as cavernous limestone or unconsolidated

sand, which stores, conducts, and transmits large quantities of water easily.

Aquitard (confining layer): sediment or rock that does not transmit water easily and thus hinders the flow of the water.

Aquiclude: sediment or rock that transmits no water.

Archaeological artifact: something created by humans usually for decorative or practical purposes; physical evidence of human presence.

Artesian wells: see *Spring*.

Asthenosphere: the layer of the Earth that lies beneath the lithosphere; it is believed to have a plastic consistency.

Average: the mean of a set of numbers.

Azimuth scale: a circular scale that goes clockwise from 0 at the north point through 360 degrees.

B

Backreef: the region of shallow water shoreward of the reef; often a lagoon.

Balloon: small, gas-filled pouch usually composed of the mineral hydromagnesite that is thought to form when pressurized mineral-saturated water seeps through cracks and upon meeting moonmilk on its way out, it expands like a rubber balloon.

Basalt: a fine-grained, dark, mafic igneous rock composed largely of plagioclase feldspar and pyroxene minerals.

Basin: in tectonics, a circular, syncline-like depression of rocks. In sedimentology, the site of accumulation of a large thickness of sediments.

Bathymetric map: a map representing a body of water's bathymetry.

Bathymetry: the measurement of water depth or the mapping of sea-floor topography in a body of water, such as the ocean or a lake.

Bell Canyon Formation: Permian marine formation of sandstone, siltstone, and some limestone; it extends from the reef margin into the basin. **Billion:** a term representing numbers that are 10^9 , or 1,000,000,000. The Earth is approximately 4.6 billion years old.

Biochemical sedimentary rock: a sedimentary rock, such as limestone, formed from elements extracted from sea water by living organisms or sedimentary rocks derived primarily of pieces of organisms (i.e. shells or plant fragments).

Bivalves: an animal (as a clam) with a 2-valved shell. **Bluff:** a high steep bank; a cliff.

Brachiopods: an invertebrate animal with a pair of protective shells, a stalk anchoring it to the floor, and tiny tentacles to catch food. They came in all shapes and sizes before they all nearly became extinct at the end of the Permian Period.

Brine: a strong saline solution.

Bryozoans: a phylum of animals, often called “moss animals,” that had a fan-like or boxwork-like frame built from colonies of individual organisms.

C

Calcite: a rhombohedral, carbonate mineral with the chemical composition of CaCO_3 (calcium carbonate).

Capitan Aquifer: karst aquifer in the Capitan Formation.

Capitan Limestone: Permian marine limestone formation composed of reef deposits and abundant marine fossils (reef). **Carbonate:** a group of minerals with the base chemical composition of CaCO_3 (calcium carbonate).

Carbonic acid: a mild, naturally occurring acid, formed when water combines with atmospheric and/or soil CO_2 , which is very common in groundwater and readily dissolves carbonates and sulfates to form karst landscapes.

Carbon cycle: the cycle of carbon through the earth's atmosphere as CO_2 , geosphere (in carbonate rocks and reefs), and ecosystems in which carbon dioxide is used by photosynthetic organisms and then ultimately restored to the atmosphere by respiration.

Carbon dioxide (CO_2): a colorless greenhouse gas that plays an integral role in the geological cycle; creates carbonic acid (H_2CO_3) when dissolved in water (as is found in carbonated sodas).

Carlsbad Caverns National Park: located in south eastern New Mexico in the Guadalupe Mountains, the park was designated a National Park in 1930; it includes 46,766 acres and more than 86 other smaller caves.

Castile Formation: Permian evaporite formation in the Delaware Basin of layered gypsum, anhydrite, and halite. **Cave:** a natural open space underground, generally with a connection to the surface and large enough for a person to enter.

Cement: mineral material that precipitates from water and fills the voids between grains, holding the grains together.

Cementation: the phase of lithification where cement fills the voids between grains attaching them to each other.

Cephalopods: an organized group of mollusks in the Class Cephalopoda that are free-swimming aggressive carnivores with tentacles to capture prey and a siphon to move using jet-propulsion. This Class includes Nautiloids and Ammonites.

Chemical composition: the specific chemical (elemental) make-up of rocks and minerals.

Chemical sedimentary rock: a sedimentary rock that is formed at or near its place of deposition by chemical precipitation, usually from sea water or other saline waters.

Chemical weathering: the process in which chemical reactions alter or destroy minerals when rock is in contact with air or water solutions.

Clastic sedimentary rock: a sedimentary rock formed from clasts that were mechanically transported.

Clasts: mineral particles or sediments.

Clay: a) one of a number of hydrous aluminosilicate minerals formed by weathering and hydration of other silicates; b) any mineral fragment smaller than 1/255 mm.

Cleavage: the tendency of a mineral to break along preferred planes. The majority of minerals break along 1, 2, or 3 cleavage planes.

Climate: the average weather conditions, along with the range of conditions, of a region over a year.

Climate change: a change in the average weather conditions, along with the range of conditions, of a region.

Clinometer: an instrument that is used to measure angles of elevation or inclination.

Coal: a sedimentary rock which is a product of stratified plant remains; contains more than 50 percent carbon compounds and burns readily.

Columns: speleothems formed by: 1) the unions of stalagmites and stalactites, 2) the union of a stalactite with the floor, 3) the growth of a stalagmite to the ceiling.

Compass: a device for determining directions by means of a magnetic needle or group of needles that turns freely on a pivot and points to the magnetic north.

Compass directions: the four cardinal directions are north, south, east, and west.

Compressional stress: a force that compresses or squeezes a body or rock layers together.

Condensation: the conversion of a substance (such as water) from the vapor state to a denser liquid or solid state usually initiated by a reduction in temperature of the vapor.

Confined aquifer: an aquifer that is separated from the Earth's surface by an overlying aquitard.

Confining unit: see *Aquitard*.

Conglomerate: a sedimentary rock composed of rounded, coarse-grained sediment (such as pebbles or gravel) cemented together.

Connectivity: the amount of connected spaces in rock or sediment through which air or water can flow.

Contaminant: unwholesome or undesirable elements whose introduction into a system contaminate or make the elements of the system unfit for use.

Contamination: the process of being contaminated.

Continental crust: the crust of which the continents are composed; composed of relatively light felsic rocks such as quartz and feldspar. Continental crust is less dense than oceanic crust and therefore will be the buoyant crust at convergent plate margins.

Continental-drift hypothesis: Alfred Wegner's hypothesis that continents have moved and are still moving across Earth's surface.

Continental rift: the formation of a divergent plate margin along a belt where the continent stretches and spreads apart.

Convection: a heat transfer that occurs when warmer, less dense material rises while cooler, denser material sinks; the

main mechanism believed to drive plate tectonics.

Convergent margin (convergent plate boundary): a boundary at which two plates move towards each other so that one plate sinks (subducts) below the other; only oceanic lithospheric crust is dense enough to subduct.

Conveyor belt: see *thermohaline circulation*.

Coquina: a bioclastic sedimentary rock primarily composed of cemented shell pieces.

Coral: the calcareous or horny skeletal deposit produced by marine invertebrates. **Cracks:** breaks in rock.

Cretaceous Period: the geologic time period spanning 66 and 144 million years ago; the height of the dinosaur age and the introduction of flowering plants.

Crinoids: part of the Class Crinoidea in the phylum Echinodermata, these are sea-lily animals with segmented stalks to root them to the ground and a flower-like head with tentacles to catch prey. The stalks are most commonly found fossilized whole with the segments still together or with the segments separated as little disks.

Cross-cutting relationships: how rocks and sediments are deposited relative to previous deposits.

Cross section: a diagram depicting the geometry of geologic materials as an imaginary vertical slice.

Crust: the rock that makes up the thin, outermost layer of the Earth (oceanic crust is about 7-10km thick and continental is 30-40km thick).

Crystal: a single, continuous piece of a mineral bounded by flat surfaces that formed naturally as the mineral grew.

Crystalline: a texture describing a rock that is massive (without internal structure) and sparkling.

Crystallization: the act of forming crystals.

Crystal form: the geometric shape of a crystal, defined by the arrangement of the crystal faces.

Crystal habit: the general shape of a crystal or cluster of crystals that grew unimpeded.

Cultural materials: see *archaeological artifact*.

Cynognathus: a carnivorous, wolf-sized, mammal-like reptile (not a dinosaur) that lived on open plains in Africa and South America roughly 230-245 million years ago.

D

Daughter isotope: the decay product of radioactive decay of a parent isotope.

Decay curve: a curve on an X-Y graph indicating exponential decay.

Deflected stalactites: unusual stalactites that are curved due to either: 1) strong cave air flow, 2) disruption of the water flow down the outside of the stalactite by crusts or popcorn formed on the outside, or 3) corrosional wind eroding on one side of the speleothem.

Delaware Basin: the paleo-oceanic and sedimentary basin in southeastern New Mexico and West Texas; formed in the Permian and current hydrocarbon producer.

Density: a measurement of a substance based on its mass versus its volume (Density = Mass/Volume).

Deposition: the process by which sediment settles out of a transporting medium.

Deposits: the sediments/rocks/minerals that are left behind after transportation ceases.

Disappearing stream: a stream that intersects a crack or sinkhole leading to an underground cavity, so that the water disappears below the surface and becomes an underground stream.

Discharge: A volumetric measurement of flowing water.

Dissolution: the process of dissolving rocks and minerals with liquid (usually slightly acidic water).

Divergent margin (Divergent plate boundary): a boundary at which two lithosphere plates move away from each other; they are marked by mid-ocean ridges and rift valleys.

Dolines: see *Sinkholes*

Dolomite: a carbonate mineral with the chemical composition $\text{CaMg}(\text{CO}_3)_2$; it possesses cleavage in three directions and effervesces when powdered.

Draperies: speleothems resembling curtains that are deposited when calcite-rich solutions flow along an overhung surface where surface tension allows these solutions to cling to the ceiling and deposit calcite in thin trails.

E

Earthquake: a vibration caused by the sudden breaking or frictional sliding of rock in the Earth.

Eccentricity: the shape of the Earth's orbit around the sun (low eccentricity = more circular and high eccentricity = more elliptical) which varies on a 100,000yr cycle affecting global climate.

Ecology: the study of the life cycles, populations, and interactions of various biological species as controlled by their physical environment (living and nonliving components), including also the effect of life forms upon the environment.

Ecosystem: a community of organisms and the environment in which they live including

the non-living factors that exist and affect the community.

Effervesce: to bubble, hiss, and foam as gas escapes (like a carbonate when treated with hydrochloric acid).

El Capitan: the prominent dolomite bluff composed of the Capitan Formation in Guadalupe Mountains National Park.

Electron-spin resonance dating (ESR): a dating technique, extending up to about 1 million years, that measures the number of electrons stored in the crystal lattice of minerals; it may be used to determine the ages of carbonates, speleothems, and corals.

Element: any one of more than 100 fundamental substances that consists of atoms of only one kind and that singly or in combination constitute all matter.

El Nino: the westerly flow of warm water east from the eastern Pacific Ocean, reversing the upwelling of cold water along the west coast of North and South America and causing significant global changes in weather patterns (occurring on a 3-7 year time scale).

English system: the foot-pound-second system of units.

Environmental geologist: a geologist that studies the interaction between the geosphere, hydrosphere, atmosphere, biosphere, and human activities.

Environmental geology: the study of the interactions between the environment and geologic materials and the contamination of geologic materials.

Environmental Protection Agency (EPA): a United States governmental agency with the mission to protect human health and to safeguard the natural environment, air, water, and land, upon which life depends.

Ephemeral stream: a stream whose bed lies above the water table, so that the stream only flows when precipitation rates

exceed rates of that the water infiltrates the ground.

Erosion: the break up and removal of the Earth surface by moving water, wind, or ice.

Eruption: to force out or release suddenly and often violently something (as lava or steam) that is pent up.

Evaporation: to convert from liquid into vapor.

Evapotranspiration: the sum of evaporation from bodies of water and the ground surface and transpiration from plants and animals.

Evaporite: a chemical sedimentary rock or a mineral precipitated through the evaporation of a chemically saturated solution.

Evolution: process of changing through time.

Exponential decay: the decline of a population (isotopes, critters, etc.) at an exponential rate as expressed in the equation: $\ln(N/N_0) = k * t$ (where N_0 is the initial population, N is the final population, k is the decay constant, and t is the time passed).

Extensional stress: a force that extends or pulls a body or rock layers apart.

External mechanism: a force upon geologic processes outside of the geologic medium itself (i.e. climate, tectonics, humans).

Extinct: no longer existing (i.e. an extinct animal).

Extinction: the act of making extinct; extinction events caused by different reasons have occurred periodically throughout geologic history.

F

Fault: a fracture in rocks where one rock body slides past another.

Fauna: animal life.

Feedbacks: complex interactions between different systems, which then interfere with each other.

Feldspar: a silicate mineral with varying chemical compositions depending on the type of feldspar ($AlSiO_2$); it possesses 2-directional cleavage and potassium feldspar is often pink or flesh colored while sodium or calcium-rich feldspar have linear striations (they appear as thin lines on the crystal face).

Felsic: an adjective used to describe a light-colored igneous rock poor in iron and magnesium content, abundant in the minerals feldspars and quartz.

Fissures: see *Cracks*.

Flora: plant or bacterial life.

Flowstone: common carbonate speleothem that forms in thin layers, initially taking the shape of the underlying floor or wall bedrock beneath, but then becomes rounded as it gets thicker.

Fold: a planar set of rocks that has been strongly warped and crinkled, presumably by ductile deformation.

Foliation: alignment of minerals or compositional banding of mineral concentrations including cleavage, found in a metamorphic rock.

Footwall: the rock or sediment below an inclined fault.

Forereef: the steep slope basinward of the reef composed of cemented reef talus that broke off and slid downslope creating the steeply-dipping forereef beds.

Formation: the basic unit for the naming of rocks in stratigraphy; a set of rocks that are or once were horizontally continuous, that share some distinct features of lithology, and are large enough to be mappable.

Fossil: the remnant, or trace, of an ancient living organism that is preserved in a rock or

sediment after the original organic material is transformed or removed.

Fossilization process: the process of creating a fossil through a variety of methods: 1) freezing or drying (i.e. the Siberian woolly mammoth or Egyptian mummies), 2) encapsulation in amber or tar (i.e. insects in amber or the La Brea Tar Pits in Los Angeles), 3) preserved or mineralogically replaced bones, teeth, or shells, 4) permineralization (the act of replacing plant material with minerals to produce a rock; i.e. petrified wood), 5) molds or casts of bones, shells, or plants, 6) carbonized impressions (where soft or semisoft organisms leave dark-colored, carbonized impressions when buried in sediment), 7) trace fossils (impressions of organism activity but not the organism itself, such as footprints, burrows, etc.).

Fractures: a break or crack in rocks along which fluids, such as groundwater, may flow.

G

Guadalupe Mountains: mountains in southeastern New Mexico and west Texas composed of an uplifted and exposed Permian reef and the associated basin.

Guadalupe Mountains National Park: located in west Texas in the southeastern edge of the Guadalupe Mountains, the park was designated a National Park in 1972; it includes 86,415 acres and boasts the highest peak in Texas, Guadalupe Peak.

Guadalupe Peak: located in Guadalupe Mountains National Park this peak, standing at 8,749 feet, is the highest point in Texas. It is composed of the Capitan Formation with apparent reef and forereef deposits.

Gastropods: any of a large class (Gastropoda) of mollusks (as snails and slugs) usually with a soft unsegmented body enclosed in a calcareous shell.

Geochemistry: the study of the chemical composition and chemical reactions within Earth materials.

Geochronologist: a geologist that uses the rates of radioactive decay of certain elements in rocks to determine their age and the time sequence of events in the history of the Earth.

Geochronology: the science of absolute and relative dating of geologic events and materials.

Geology: the study of the Earth, including its composition, processes, and history.

Geologic cross-section: a slice cut through the Earth or an Earth structure revealing the internal composition.

Geologic formation: see *Formation*.

Geologic history: the sequence of geologic events that has occurred in a region.

Geologic map: a map showing the distribution of rock units and structures across a region.

Geologic principle: an explanation of a set of related geologic observations or events based upon proven hypotheses and verified multiple times by detached groups of researchers.

Geologic time scale: the division of geologic history into eras, periods, and epochs accomplished through stratigraphy and paleontology.

Geomorphologist: a geologist who studies how the Earth's landscapes responds to specific geologic events such as climate changes, tectonic events, or human activity in hopes of predicting landscape changes in the future.

Geomorphology: the study of the Earth surface landforms and the processes and causal mechanisms (such as climate and geology) by which they are shaped.

Glacial deposits: sediment deposited in glacial environments (may range from clay-size to large boulders).

Glacial striations: abrasion marks on a rock left by a glacier containing sediment at its base.

Glaciation: a period of time during which glaciers grew and covered substantial areas of the continents; the most recent Pleistocene glaciation (the Ice Age) reached its peak approximately 18,000 years ago and ended about 10,000 years ago.

Glacier: A river or sheet of ice that slowly flows down mountains or across the land surface, respectively, and lasts year round.

Glossopteris: an extinct group of seed plants that arose during the early Permian Period and became a dominant part of the southern flora of Pangea until they dwindled to extinction by the end of the Triassic Period.

Gneiss: a banded or foliated metamorphic rock derived from metamorphosed granite or schist.

Goat Seep Formation: Permian-age, dolomitized limestone composed of abundant fossils; beginning of reef building in the Delaware Basin (forereef). **Gorge:** a canyon carved by running water.

Grain size: the size of a fragment of a mineral crystal or rock; the sediment classifications range from: < 1/256mm (clay), 1/256mm – 1/16mm (silt), 1/16mm – 2mm (sand), 2mm - 64mm (pebbles), 64mm – 256mm (cobbles), and > 256mm (boulders).

Granite: a felsic, igneous rock with large, intergrown mineral crystals; primarily contains quartz and feldspar minerals.

Gravel: another term for pebbles (see grain size).

Grayburg Formation: Permian marine dolomite and sandstone layers composed of fossils (beginning of reef in the Delaware

Basin). **Great Plains:** a geographic region of broad, gently-sloping land in the central United States constructed from eroded materials off of the Rocky Mountains.

Greenhouse gases: atmospheric gases, such as carbon dioxide, water, and methane that regulate the Earth's atmospheric temperature by absorbing infrared radiation.

Groundwater: water that resides under the surface of the Earth, mostly in pores or cracks of grains; it is expressed as surface water in most lakes and rivers.

Groundwater recharge: the process of adding water to an aquifer through either surface water infiltration at specific spots (sinkholes or rivers) or through wide areas (bedrock or porous sediment).

Groundwater discharge: the process of removing groundwater from an aquifer through either specific spots (springs or wells) or over larger areas (springs, seeps, or rivers).

Guano: accumulations of dung in caves, usually from bats.

Gypsum: a sulfate mineral with the chemical composition of $\text{CaSO}_4 \cdot 2(\text{H}_2\text{O})$. There are three polymorphs- selenite, satin spar, and alabaster.

H

Half-life: the time it takes for one-half of a homogeneous group of a radioactive element's parent isotopes to decay.

Halite: an evaporite mineral with the chemical formula of NaCl. Commonly known as "table salt" it possesses 3-directional cleavage and is usually transparent or translucent.

Hanging wall: the rock or sediment above an inclined fault.

Hardness: a mineral property used to identify the mineral; the 1-10 Mohs hardness scale ranges from talc at 1 to diamond as 10.

Helictites: contorted speleothems that are formed when calcite-laden waters under hydrostatic pressure seep through tiny pores in the rock and are deposited in any direction.

Hot spot: a fixed location at the top of the mantle where exceptional temperatures cause melting of the overlying lithosphere and plate (i.e. Hawaiian Islands and the Yellowstone Hot Spot).

Hydrocarbons: a chain-like or ring-like molecule made of hydrogen and carbon atoms; petroleum and natural gas are hydrocarbons.

Hydrochloric acid (HCl): an acid that causes effervescence when put in contact with a carbonate rock or mineral.

Hydrogen sulfide (H₂S): a gas produced by hydrocarbons in contact with sulfur-bearing minerals and rocks.

Hydrogeology: the study of groundwater, its movement, and its reaction with rock and soil.

Hydrologic cycle: the continual passage of water from reservoir (such as surface water, groundwater, and atmospheric liquid water) to reservoir in the Earth system.

Hydrologist: a professional that studies groundwater and surface water.

Hydromagnesite: a carbonate mineral with the chemical formula of $Mg_5(\text{CO}_3)_4(\text{OH})_2 \cdot 4\text{H}_2\text{O}$, Hydrated Magnesium Carbonate Hydroxide, often found in caves.

Hypothesis: an educated guess that includes a prediction about what will happen, a possible explanation for why it will happen, and a test through experimentation and observation.

I

Ice cores: columns of ice that are obtained by drilling vertically through a glacier and collected in order to study the ice layers.

Igneous rock: rock that forms when hot molten rock (lava above ground or magma beneath the Earth's surface) cools quickly or slowly.

Index fossil: a fossil usually with a narrow time range and wide spatial distribution that is used in the identification of related geologic formations.

Infiltration: the passage of water into or through sediment or rock by filtering or permeating.

Injection well: a well through which dye or contamination can be introduced to an aquifer.

Inner core: the inner section of the Earth's core consisting of solid iron alloy; 5,155km from the Earth's surface to the Earth's center at 6,371km.

Inorganic: not composed of living carbon molecules.

Interlocking crystals: mineral crystals that have grown together as an igneous rock cooled from lava or magma.

Interpret: to explain or tell the meaning of; to present technical information in understandable terms.

Internal mechanisms: forces upon geologic processes inside the geologic medium itself (i.e. rock type, topography, etc.).

Island Arc: a chain or arc of islands formed by volcanoes along a convergent plate boundary between two oceanic plates (i.e. Aleutian Islands or Japan).

Isotope: one of several forms of an element, all having the same number of protons in the nucleus, but different numbers of neutrons and therefore different atomic weights.

Iterative process: a process where studies and observations are repeated, each time a variable may be tweaked to approach better understanding.

J

Joints: naturally formed cracks in rocks.

K

Karst landscape: landforms produced primarily through the dissolving of rock, such as limestone, dolomite, marble, gypsum, and halite; features include sinkholes, caves, large springs, dry valleys, and sinking streams.

Karst aquifer: an aquifer where the water resides and flows through fractures or other openings that have been created through natural dissolution processes.

L

Lagoon: a body of shallow seawater separated from the open ocean by a barrier island.

Landscape: the natural features of a land surface of a region in the aggregate.

Legend: a map key or guide to symbols representing information on a map.

Limestone: a sedimentary rock primarily consisting of calcium carbonate, CaCO_3 , primarily in the form of the mineral calcite.

Lithology: the study/type of rocks. From the Greek “lithos” meaning rock.

Lithosphere: the relatively rigid, nonflowing, outer 100–150 km thick layer of the Earth; comprised of the crust and the upper part of the mantle.

Loma Prieta earthquake: a 7.1 (Richter scale) earthquake that occurred along the San Andreas Fault in California on October 17, 1989.

Long-axis: the longest of imaginary line axes through an object (the “length” direction rather than the “width”).

Luminescence dating: a dating technique, extending up to about 800,000 years, that measures the number of electrons stored in the crystal lattice of minerals when the sample is exposed to light; it is primarily used to determine the ages of quartz and feldspar.

Luster: the way a mineral scatters light. Lusters may be: metallic, nonmetallic, waxy, transparent, translucent, shiny, etc.

Lystrosaurus: a 3-foot-long, plant-eating, mammal-like reptile (not a dinosaur) with tusks that lived during the Permian and Triassic periods on Pangea.

M

Mafic: an adjective used to describe a dark-colored igneous rock rich in iron and magnesium content.

Magma: molten rock below the Earth’s surface.

Magnetic: an object having the property of attracting iron and producing a magnetic field external to itself.

Mantle: the thick layer of rock below the Earth’s crust and above the core (from about 10km at the base of the oceanic crust and 40km at the base of the continental crust to the depth of 2,900km).

Map scale: a scale to determine distance on the map relative to real distance on the Earth.

Map symbols: a set of symbols used on maps to represent real objects or features on the Earth’s surface.

Marble: a metamorphic rock consisting primarily of recrystallized limestone or the minerals calcite or dolomite; it often contains marine fossils and is used as decorative stone.

Marine environment: the ocean environment- may be shallow or deep marine.

Melting: transformation of a solid into a liquid; occurs when chemical bonds holding mineral atoms or ions to the crystal lattice are broken by excessive thermal vibrations.

Mesosaurus: a crocodile-like, fresh-water dwelling reptile (not a dinosaur) that lived from the late Carboniferous period to the early Permian Period in South America and Africa; it was one of the first aquatic reptiles.

Metallic luster: a mineral appearance similar to metal (shiny, opaque, pliable).

Methane: a gas with the chemical formula of CH₄.

Metamorphic rock: a rock that forms when metamorphism changes a preexisting rock into a new rock.

Metamorphism: the process by which elevated temperatures, pressures, or shearing under elevated temperatures alter one of the three types of rock into a metamorphic rock without melting it.

Metric system: a decimal system of weights and measures based on the meter and on the kilogram.

Milankovitch cycles: variations in the Earth's movement around the sun on time scales of roughly 100,000 years, 41,000 years, and 22,000 years which affect global climate cycles.

Milutin Milankovitch: a Serbian astronomer and geophysicist who determined that changes in the Earth's orbit occurred cyclically and were responsible for some of the global climate changes.

Mineral: a homogeneous, naturally occurring, solid, inorganic substance with a definable chemical composition and an internal structure characterized by an orderly arrangement of atoms, ions, or molecules in a lattice.

Mineralogy: the study of the chemistry and physical properties of minerals.

Model: a scale replica or schematic diagram (two-dimensional or three-dimensional) of a physical feature or process.

Mollusks: any of a large phylum (Mollusca) of invertebrate animals (as snails, clams, or squids) with a soft unsegmented body usually enclosed in a calcareous shell.

Molten: melted rock.

Moonmilk: a carbonaceous liquid (when wet) or a white deposit formed of aggregates of very fine carbonaceous crystals (when dry).

Muscovite mica: a silicate mineral with the chemical formula of KAl₂(AlSi₃O₁₀)(F, OH)₂; it possesses a sheet-like 1-directional cleavage, it is transparent to translucent, and the sheets are semi-flexible.

N

National Park Service: a national agency established in 1916 conserve natural resources and historical sites in the United States and provide for their enjoyment; under the US Department of the Interior.

Natural gas: gaseous hydrocarbons that are formed from decayed organisms and are trapped in rocks. Primarily composed of methane.

Nautilus: a Cephalopod mollusk with a spirally coiled shell composed of a series of chambers that grow with age. The animal has a siphuncle that moves liquid from chambers and replaces it with gas giving the animal buoyancy. Today, the sole surviving genus is found in the deep ocean of the South Pacific and the Indian Ocean.

Nonmagnetic: is not magnetic (see *Magnetic*).

Nonmetallic luster: the mineral appearance does not resemble metal (see *Metallic luster*).

Normal fault: a fault in which the hanging-wall block moves down the fault slope in relation to the footwall.

O

Obliquity: the angle between the planes of the Earth's equator and orbit (plane of the ecliptic) varies between 22.5° and 24.5° with a frequency of about 41,000 years causing global climate changes (currently the tilt is 23°27').

Ocean bottom water: the cold, dense ocean water flowing at the sea floor.

Ocean cores: long sections of oceanic sediments and rocks vertically extracted from the ocean floor by drilling; used to examine a continuous record of marine geology, flora, and fauna.

Ocean surface water: the warm, lighter ocean water flowing on the surface of the sea.

Oceanic cycle: see *Thermohaline circulation*.

Oceanic crust: the crust beneath the oceans; composed of dense gabbro and basalt. Oceanic crust is denser than Continental crust and therefore will subduct below continental crust at convergent plate margins.

Oceanic spreading ridge: the formation of a divergent plate margin along a belt where the oceanic plate stretches and spreads apart.

Ogallala Aquifer: a large aquifer in sand and gravel extending from Texas to South Dakota in the plains area.

Oil: a hydrocarbon byproduct of decayed organisms that broke down anaerobically and were preserved in rock layers.

Ooids: round, sand-sized carbonate sediment formed in marine settings by accumulation of carbonate mud around a nucleus rotated by wave agitation.

Organic material: material composed of carbon from an organism.

Orthoclase: a mineral with the chemical composition KAlSi_3O_8 ; otherwise known as potassium feldspar, displays a 2-directional cleavage, and may have a pinkish or flesh color.

Orogeny: a mountain-building event.

Outer core: the section of the core, between 2,900 and 5,150 km deep, that consists of liquid iron alloy.

P

Paleontological records: records of ancient life through fossils.

Paleontology: the study of fossils, ancient flora and fauna, and their evolution as preserved in the rock record.

Paleoenvironment: an Earth environment at a given time in the past.

Paleoclimate: the climate of a given period of time and place in the geologic past.

Paleokarst: ancient karst features that have subsequently been buried by other sediments.

Paleozoic Era: a geological division of time that spanned from 545–245 million years ago.

Pangea: a supercontinent that assembled at the end of the Paleozoic Era.

Parent isotope: a radioactive isotope that undergoes decay and produces daughter isotopes.

Parent rock: the original rock, or protolith, from which a metamorphic rock forms.

Pavement: an armored surface of sediment (often gravel) resistant to erosion; generally created when the surrounding material (usually finer-grained sediment) is eroded away leaving the larger sediments.

Pearls: a concentric spherical, cylindrical, elliptical, and even cubical concretion found

in shallow cave pools ranging from sand grain-size to golf ball-sized. Cave pearls form when water dripping into the pool loses carbon dioxide and precipitates calcite around a nucleus of sand, bones, or fragments of soda straws or rafts. The typical roundness is controversial and believed to be due to either the uniform growth of the pearl or due to rotation of the pearl when dripping water agitates the pool.

Pebbles: sediment within the 2mm - 64mm grain size range.

Peer review: the standard practice of evaluating the intellectual merit and the broader impacts of scientific research by other scientists within the community.

Permeability: the degree to which a rock or sediment allows fluids to pass through it via interconnected networks of pores and cracks.

Permeable layer: a rock or sediment layer through which water can pass.

Permian extinction: the largest extinction known in geologic history, serving as the boundary between the Permian Period and the Tertiary Period, 245 million years ago, killed up to 90% of all species living on Earth. It was believed to have been caused by extreme volcanic activity that released gases into the atmosphere and changed the Earth climate.

Permian Period: a geologic period between approximately 285 million years and 245 million years ago in the Paleozoic Era.

Perennial stream: a river that flows throughout the year.

Petroleum geologist: a geologist involved in exploration for and production of oil and natural gas resources.

Petrology: the study of rocks and their formation.

Physical weathering: the process in which intact rocks break into smaller pieces or grains (becoming loose sediment).

Physiographic provinces: geographic landmasses that are classified by physiological Characteristics (i.e. the Basin and Range, the Rocky Mountains, the Colorado Plateau, etc.).

Phreatic zone: the zone below the water table where all of the pore spaces are saturated or filled with water.

Plane of the ecliptic: the plane as defined by a planets orbit around the sun.

Planview map: a map of a feature from above.

Plate: one of about 20 distinct pieces of the relatively rigid Lithosphere; on these ride the dense oceanic crust and the less dense continental crust.

Plateau: a land area having a relatively level surface raised sharply above adjacent land on at least one side.

Plate boundaries: the border between two adjacent Lithospheric plates.

Pollen: spores of a plant.

Pollen records: accumulations of pollen preserved in geologic deposits through time; often used to evaluate changes in vegetation through time.

Popcorn: a knob-shaped speleothem composed of concentric layering of micro-crystalline calcite and formed either in air (subaerially) from thin, evenly distributed solution films evaporating, or within still cave pools (subaqueously).

Pore space: the space between sediment that would allow the passage of air or water.

Porosity: the percentage of the bulk volume of a rock or sediment that is occupied by pore space.

Potassium/ Argon dating (K-Ar): a dating technique used on igneous rocks that measures the ratio of decayed potassium (K^{40}) to its daughter product, Argon (Ar^{40}). While the resolution is nearly a million years, it may be used to determine the age

of rocks from 4.3 billion years to 100,000 years old.

Precession: The gradual conical path traced out by Earth's spinning axis; simply put, it is the "wobble" of the Earth's axis which varies approximately every 22,000 years causing global climate changes.

Precipitation: (1) the process by which atoms dissolved in a solution come together and form a solid; (2) rainfall or snow.

Principle of cross-cutting relationships: The principle that if one geologic feature cuts across another, the feature cut is the older of the two.

Principle of original continuity: The principle that sediments usually are deposited in continuous sheets.

Principle of original horizontality: the principle that sediments are usually deposited in a horizontal fashion.

Principle of superposition: the principle that sediments which accumulate through time are successively younger towards the top of the sequence (the oldest is on the bottom and the youngest on the top).

Principle of Uniformitarianism: the principle which states that the present is the key to the past (that processes occurring today in the world similarly occurred at similar rates in the past).

P- Waves: compressional seismic waves that move through the body of the Earth.

Pyrite: a gold, metallic mineral with the chemical composition of FeS_2 .

Q

Quartz: a silicate mineral with the chemical composition of SiO_2 ; it has a hardness of 7, possesses no cleavage, is generally transparent to translucent, and may be found in a variety of colors (smoky, pink, colorless, purple).

Quaternary Period: the geologic time period extending from approximately 2

million years ago to about 10,000 years ago; it is commonly noted for its extensive glaciations.

Queen Formation: Permian-age, marine dolomite and sandstone layers composed of fossils in the Delaware Basin; it also contains ripple marks and channels suggesting shallow water levels (backreef).R

Radioactive decay: the process by which a radioactive atom undergoes fission or releases particles.

Radioactive isotope: an unstable isotope of a given element.

Carbon 14 (Radiocarbon): a heavy radioactive isotope of carbon of mass number 14 used especially in dating archaeological and geological materials.

Radiometric dating: the science of dating geologic events in years by measuring the ratio of parent atoms to daughter atoms in a rock's radioactive elements.

Recharge area: a region of porous and permeable rock or sediment where meteoric water replenishes the aquifer.

Reef: a porous, often delicate mass of calcium carbonate and some silicon composed of skeletons of marine corals and sponges.

Results: the outcomes of a scientific experiment.

Resurgence area: area where water emerges or discharges from the aquifer and becomes surficial water.

Resurgent stream: the reemergent disappearing stream to the surface.

Reverse (thrust) fault: a steeply dipping fault on which the hanging wall slides up relative to the footwall.

Rhombohedron: a 3-dimensional cube composed of four parallelograms with four equal sides and sometimes one with no right angles.

Richter scale: an open-ended logarithmic scale for expressing the magnitude of a seismic disturbance (as an earthquake) in terms of the energy dissipated in it with 1.5 indicating the smallest earthquake that can be felt, 4.5 an earthquake causing slight damage, and 8.5 a very devastating earthquake.

Right triangle: a triangle having a right angle.

Rift zone: an area where a fault trough is formed in a divergence zone or other area of tension.

Riparian zone: area along the bank of a natural watercourse (such as a river) or sometimes of a lake or a tidewater.

Rock: a coherent, naturally occurring solid, consisting of an aggregate of minerals or a mass of glass.

Rock cycle: the succession of events that results in the transformation of Earth materials from one rock type to another, then another, and so on.

Runoff: water that is unable to permeate sediment or rock because of saturation.

Rustler Formation: Late Permian-age, marine formation of dolomite, siltstone, anhydrite, and halite; deposited as sea level lowered in the Delaware Basin. **S**

San Andres Formation: Early Permian-age marine formation of dolomite and chert deposited as sea level began to rise (beginning of Permian reef formation in the Delaware Basin). **Sand:** sediment that is within the grain size range of 1/16mm–2mm.

Sandstone: a sedimentary rock composed of sediment grains within the size range of 1/16mm–2mm.

Satellite image: images of Earth features created from data collected by orbiting satellites; these data are composed of signals within the electro-magnetic

spectrum such as the visible, infrared, and thermal ranges.

Saturation: filled completely with something that permeates or pervades such as water, air, or chemical compounds.

Scale: a proportion between two sets of dimensions (as between those of a drawing or a model and its original).

Schematic diagram: an approximate drawing for demonstration purposes rather than an actual representation of an objects.

Schist: a metamorphic rock with foliation and often recrystallization of minerals such as garnet; its protolith is slate.

Scientific community: the group of scientists who research and apply scientific topics as a whole.

Scientific law: a statement of fact generally accepted to be true and universal meant to explain, in concise terms, an action or set of actions; sometimes it may be expressed in terms of a single mathematical equation (such as the law of gravity and the law of thermodynamics).

Scientific Theory: an explanation of a set of related observations or events based upon proven hypotheses and verified multiple times by detached groups of researchers.

Sea Level: the ocean surface level at its mean position midway between mean high and low water which is used as a global datum, representing zero elevation, to determine the relative elevation of the land surface.

Sediment: pieces of rock or minerals that are not cemented together.

Sedimentary rock: a rock that forms either by the cementing together of fragments of preexisting rocks or by the precipitation of mineral crystals out of water solutions at or near the Earth's surface.

Sedimentology: the study of sediments and their deposition.

Seismic-reflection profile: a cross-sectional view of the crust made by measuring the reflection of artificial seismic waves off boundaries between different layers of rock in the crust.

Seismic waves: waves of energy emitted at the focus of an earthquake or a man-made source of energy.

Seismology: the study of earthquakes and the Earth's interior as revealed by earthquake and synthesized waves.

Seven Rivers Formation: Permian-age, shallow marine formation of sandstone and Mudstone in the Delaware Basin (backreef).

Shadow zone: a region on the opposite side of the globe that does not receive S-waves from an earthquake because they do not travel through the liquid outer core.

Shale: a sedimentary rock composed of cemented fine-grained clay sediments.

Shelf: a flat edge of a continent covered by an ocean.

Shield volcano: a volcano with broad, gently sloping sides, formed by either from low viscosity basaltic lava or large sheets of deposited ash.

Siliciclastic sedimentary rock: a sedimentary rock composed of cemented sediments or clasts.

Silt: sediment within the 1/256mm–1/16mm grain size.

Sinkhole: a funnel-shaped depression in a karst area, commonly with a circular or bowl-shaped pattern. Sinkhole drainage is subterranean and sinkhole size is usually measured in meters or tens of meters. Common sinkhole types include those formed by dissolution, where the land is dissolved downward into the funnel shape and by collapse where the land falls into an underlying cave.

Sinking stream: a surface stream that loses water to the underground in a karst region (also called a *disappearing stream* or an *underground stream*).

Slate: a metamorphic rock formed by metamorphosis of shale; previously used as chalk boards.

Soda straw: a hollow, elongate, and generally translucent tube of calcite equal in diameter to the water drops conducted along their length; a speleothem representing the earliest growth of stalactites.

Solar flux: changes in the intensity of solar radiation to the Earth due to sunspots, solar flares, or changes in the Earth's orbital pattern.

Solution: a) an act or the process by which a solid, liquid, or gaseous substance is homogeneously mixed with a liquid or sometimes a gas or solid; b) a homogeneous mixture formed by this process; c) the condition of being dissolved.

Speleogenesis: the creation and formation of speleothems.

Speleothem: a formation that grows in a limestone cave by the accumulation of travertine precipitated from water solutions dripping, flowing down the walls, or flowing on the floor in the cave.

Sponge: the common name for an animal in the Phylum Porifera that primarily resides in shallow, temperate marine waters in colonies. Permian sponges, such as *Girvanella*, *Mizza*, and *Solenopora*, are the most abundant organisms visible in the rocks; over 4,500 species are known today.

Spring: a natural artesian well where groundwater flows to the surface.

Stalactite: a conical speleothem that begins as a plugged soda straw on the ceiling and grows with precipitation from carbonate-rich water flowing down with gravity (stalactites hang "tite" to the ceiling).

Stalagmite: speleothems that are upward-growing, massive calcite mounds deposited from dripping water (stalagmites “mite” reach the ceiling).

Strata: layers of rocks (usually sedimentary rock).

Stratigraphic column: a cross-section diagram of a sequence of strata summarizing information about the rock sequence.

Stratigrapher: a geologist that investigates the time and space relationships of rocks, on a local, regional, and global scale throughout geologic time.

Stratigraphy: the science of the description, correlation, and classification of strata in sedimentary rocks, including the interpretation of the depositional environment of those strata.

Stratovolcano: a large cone-shaped volcano with steep slopes consisting of alternating layers of lava and ash.

Striations: linear scratches in the rock or mineral.

Stromatolite: a laminated sedimentary fossil formed from layers of colonies of blue-green algae. **Structural geology:** the study of rock deformation in response to the application of a force.

Subduction: the process of an oceanic plate dipping under another plate at a convergent plate boundary.

Sulfur: a sulfate mineral whose chemical composition is S.

Sulfuric Acid (H₂SO₄): a strong acid believed to have been the primary agent of dissolution at Carlsbad Cavern, other caves at Carlsbad Caverns National Park, and several other caves around the world.

Supercontinent: a continent larger than those found today.

Surface water: water flowing on the surface of the Earth (includes oceans, rivers, lakes, etc.).

Surface waves: seismic waves that travel along the Earth’s surface.

Surficial: relating to the surface of the Earth.

Surveying: applied mathematics that determines: 1) the area of any portion of the Earth’s surface, 2) the lengths and directions of boundary lines of this portion, 3) the contour of the surface, and 4) accurately delineates all of these measurements on paper.

Swallow Hole: see *Sinkhole*.

S-Waves: seismic shear waves that pass through the body of the Earth.

Syncline: a trough-shaped fold that is concave-up.

T

Talus: a deposit of large angular fragments of physically weathered bedrock, usually at the base of a cliff or steep slope.

Tansill Formation: Permian-age, shallow marine formation of dolomite, gypsum, red clay, and silt in the Delaware Basin (reef - backreef).

Technology: the practical application of knowledge especially in a particular area (i.e. scientific technology).

Tectonics: the science of regional geologic features (such as mountain belts), plate movements, and their consequences.

Terra Rossa: soils or ancient soils developed on limestone in warm climate regions.

Texture: rock characteristics of grain or crystal size, size variability, rounding or angularity, and preferred orientation.

Theory of Plate Tectonics: the theory that the outer layer of the Earth (the lithosphere)

consists of separate plates that move with respect to one another.

Thermohaline Circulation: the upwelling and downwelling of less dense warm and denser cold ocean water, respectively, drive this global oceanic circulation.

Tilt: see *Obliquity*.

Timeline: a linear representation of events in chronological order through time.

Topographic map: a 2-dimensional map representing the 3-dimensional shape of the Earth's surface, above and below sea level, using contour lines and hachures to represent elevations.

Topographic profile: a 2-dimensional slice through a topographic map representing surface elevation changes.

Topography: the configuration of the Earth's surface including its relief and the position of its natural and man-made features.

Transform plate boundary: a boundary at which the lithospheric plates slip laterally past each other.

Translucent: able to transmit light through but diffusing it so that objects beyond cannot be seen clearly.

Transparent: able to transmit light without diffusion so that objects lying beyond are seen clearly.

Travertine: a secondary deposit of carbonate minerals formed in caves and around hot springs where cooling, carbonate-saturated groundwater is exposed to the air.

Tree rings: the rings seen in tree trunks when they are cut perpendicular to their growth; each ring represents a year of growth and may be used to determine the age of the tree.

Trench: a deep elongate trough defining a convergent plate boundary.

Trilobites: any of numerous extinct Paleozoic marine arthropods (group Trilobita) having the segments of the body divided by furrows on the dorsal surface into three lobe.

Trona: a gray-white or yellowish white mineral composed of sodium carbonate, $\text{Na}_3(\text{HCO}_3)(\text{CO}_3) \cdot 2\text{H}_2\text{O}$.

U

Ultraviolet light: light situated beyond the visible spectrum at its violet with wavelengths shorter than visible light.

Unconfined aquifer: an aquifer that intersects the surface of the Earth.

Underground stream: a stream that flows in cavities below the surface of the Earth.

United States Geological Survey (USGS): an agency within the Department of the Interior to collect, monitor, analyze, and provide scientific understanding about natural resource conditions, issues, and problems.

Uplift: a broad and gentle epeirogenic increase in the elevation of a region without a eustatic change of sea level.

Uranium/Thorium dating: dating technique that uses the decay of U^{238} to Th^{230} to determine the age of geologic materials.

V

Vadose zone: the subsurface area between the surface of the land and the water table that contains air within the pore spaces or fractures (the unsaturated zone).

Vesicular: a texture in igneous rocks containing small cavities formed by trapped air bubbles in cooling lava.

Viscosity: the property of resistance to flow in a fluid or semifluid (maple syrup in winter has a high viscosity, whereas hot honey has a low viscosity).

Volcanic ash: tiny glass shards formed when a fine spray of volcanic lava freezes

instantly when it comes in contact with Earth's atmosphere.

Volume: a unit measuring how much "space" something occupies.

W

Water cycle: see *hydrologic cycle*

Water table: the boundary, approximately parallel with Earth's surface, that separates substrate in which groundwater fills the pores (the phreatic zone) from substrate in which air fills the pores (the vadose zone).

Water vapor: the gaseous form of water, H₂O.

Weathering: the set of all processes that decay and break up bedrock, by a combination of physically fracturing (physical weathering) or chemical decomposition (chemical weathering).

Well: a deep vertical hole in the ground dug or drilled in order to draw out water or hydrocarbons.

X

X-Y graph: a point graph with two axes, a horizontal X-axis and a vertical Y-axis.

Y

Yates Formation: Permian-age, shallow marine formation of sandstone, siltstone, dolomite, gypsum, and red clay in the Delaware Basin (backreef). **Yeso**

Formation: Early Permian-age, shallow marine formation of shale, sandstone, and Limestone in the Delaware Basin (shelf).

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Biological Dictionary: <http://biotech.icmb.utexas.edu/search/dict-search.html>

Marine Biology Encyclopedia: <http://www.bartleby.com/65/ma/marinebi.html>

Merriam Webster Dictionary on-line: <http://www.m-w.com/home.htm>

Virtual Cave: <http://www.goodearthgraphics.com/virtcave.html>

Geological Terms: <http://www.usgs.gov>

Purchasing Supplies List

Ward's Geology Catalog (1-800-962-2660, www.wardsci.com)

Minerals (pick your own collection, pkg. of 10):

- Calcite
- Dolomite (coarse or with cleavage)
- Gypsum (selenite or massive)
- Halite
- Muscovite Mica
- Pyrite
- Quartz (milky)
- Orthoclase Feldspar (pink)

Rocks (pick your own collection, pkg. of 10):

- Limestone (gray and Coquina)
- Sandstone (siliceous or red)
- Shale (carbonaceous)
- Conglomerate
- Coal (bituminous)
- Granite (porphyritic)
- Basalt (massive or vesicular)
- Gneiss (gray banded)
- Schist (mica or garnet)
- Travertine (Trona)
- Marble (coarse white)

Other hand samples:

- Stalactite
- Bryozoan (*Tabulipora Urei*) – Permian
- Brachiopods (Composite Sp.) – Pennsylvanian/Permian
- Cephalopods
- Trilobites – Devonian?
- Crinoid stems – Pennsylvanian

Mineral Testing Kits

- Pre-Made kits (minus acid)
- or
- Make your own
 - Streak plates (pkg. 10)
 - Glass plates (pkg. 10)
 - Grain size charts (pkg. 5)
 - Acid bottles (pkg. 12)
 - Magnifying glasses (individual)

Miscellaneous

- Geologic time chart
- Earth history chart
- Map of the lithospheric plates
- Dictionary of Geological Terms
- Roadside Geology of NM and TX books
- Blacklight